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Measurement tools of autism syndrome severity and selected neurocognitive processes in individuals with ASD

Karolina Krzysztofik, Wojciech Otrębski

John Paul II Catholic University of Lublin

Summary

According to the latest theories explaining the pathomechanism and course of autism spectrum disorder (ASD), this disorder is characterized by abnormalities in the development of neurocognitive processes, such as executive functions, "theory of mind", cognitive style, or sensory integration processes. The structure of these processes is not homogenous, which has implications for measurement methodology. The type of indicators of the course and development level of neurocognitive processes analyzed by a researcher entails the need to choose an appropriate measurement tool. The behavioral indicators (verbal and nonverbal behavior of the participants) are measured with the use of observation sheets. On the other hand, the neurophysiological indicators are measured with the use of high-technology equipment, such as: computed tomography (CT), functional magnetic resonance imaging (fMRI), or eye tracker. By systematizing the tools most often used by researchers to measure sensory integration processes, the level of development of "theory of mind" and empathizing skills, as well as autism severity in individuals with ASD, the article reveals the relationship between the formulated hypothesis and the type of measured indicators of the abovementioned variables. It therefore suggests that a project of research should be set by the investigator within a methodological approach that is relevant for the verification of the formulated hypothesis.

Key words: Autistic Spectrum Disorder, methods

Theoretical background for the undertaken analyses

The factors that are decisive in establishing the diagnosis of an autism spectrum disorder (ASD) are the specific profile of symptoms observed directly through behavior, manifesting themselves in the following areas:

- persistent deficits in social communication and social interaction;
- restricted, repetitive patterns of behavior, interests or activities [1].

According to DSM-5 – the newest classification of mental disorders published by the American Psychiatric Association [1] – ASD diagnosis should be based not only on the presence or absence of the above-listed symptoms, but also on determining the level of their severity in order to recognize the necessary level of support. The term "autism severity" used in this article corresponds to understanding of ASD as a spectrum of disorders with different levels of severity of symptoms, adopted in DSM-5 [1].

Behavioral indicators of autism severity are measured with the use of observational scales or structured interviews. However, researchers suggest the existence of neurophysiological and physiological indicators of autism, i.e., the features of brain structure [2, 3], genetic configuration [4] or metabolism [5] specific for people with ASD. A similar differentiation to behavioral and neurophysiological indicators can be observed in the methodology of measurement of the course and level of development of neurocognitive processes in individuals with ASD. The diversity of these tools reflects the complexity of the development of these processes, in which contemporary researchers distinguish two successive phases:

– implicit – measured through the use of implicit indicators, defined as beyond the control of the individual or neurophysiological indicators. They are measured using projective methods or high-technology equipment (e.g., functional magnetic resonance imaging (fMRI), computed tomography (CT), electroencephalography (EEG), or eye tracker);
– explicit – measured through the use of explicit indicators, defined as declarative and behavioral. It is measured using self-reports or observation sheets [6, 7].

The neurocognitive process, in development of which the above-mentioned phases are the most evident, is the process responsible for the "theory of mind" (the skill of interpreting the actions of an individual or of others, as dictated by states of mind [8]) and empathizing (the skill of interpreting emotional states of others and reacting to them in an appropriate way [8]).

The diversity of tools used for measuring the course of sensory integration processes, i.e., the neurobiological processes through which the brain, having received stimuli from all the senses, is able to identify, sort and interpret them [9], leads to the conclusion that also the development of these processes can be divided into implicit and explicit phases.

The following sections are a systematized review of tools used for measuring the mentioned variables (autism severity, the development level of processes responsible for the "theory of mind" and empathizing skills, and the course of sensory integration processes) in individuals with ASD.

Tools used for measuring behavioral indicators of autism severity

The tools used for measuring the behavioral indicators of autism severity are ASD-screening instruments for infants and toddlers. Bishop et al. [10] proposed to divide these tools to first level screeners (completed by a parent/caregiver), second level screeners (completed by a professional) and auxiliary tools used in the diagnosis of ASD. The following paragraph supplements the review made by the aforementioned authors with the tools available and popular in Poland and in Europe used for assessing babies older than one year of age, as well as the scale used in children as early as under one year of age (FYI) [11].

These authors [10] include the *Modified-Checklist for Autism in Toddlers* (M-CHAT) [12], intended for children over one year of age, in the group of first level screeners. The Polish version of this scale [13] is available on the "Badabada" program website (http://badabada.pl/pro/m-chat-r-f). We believe that this group of tools should be complemented by other screeners – one of them is the *First Year Inventory* (FYI) [11]. The undoubted value of this tool is the fact that it is intended for children in early stage of their development – in their first year of life. This tool has not yet been translated into Polish. Other tools not mentioned in the systematic review by Bishop et al. [10] are the *Quantitative Checklist for Autism in Toddlers* (Q-CHAT) [14] (for children over one year of age), scales for children over four years of age – *the Childhood Autism Spectrum Test* (CAST) [15] and *the Autism-Spectrum Quotient* (AQ). The last-mentioned tool has different versions, depending on the age of respondents: for children aged four to eleven [16], for adolescents (aged 12 to 15) [17] and for adults [18]. Both Q-CHAT and CAST scales, as well as all versions of the AQ scale have been translated into Polish by a team led by prof. E. Pisula and are available on the website of the Chair of Rehabilitation Psychology at the Faculty of Psychology at the University of Warsaw (http://www.psychologia.pl/rehabilitacja/publikacje). Original language versions can be downloaded from the Autism Research Centre website (https://www.autismresearchcentre.com/arc_tests).

In the group of second level screeners, completed by a professional, we can find *the Childhood Autism Rating Scale* (CARS) [19]. The scale is designed for both children and adults. This tool is popular with pediatrics specialists and rehabilitation practitioners in a number of countries – in Europe and on other continents.

The tools for measuring autism severity that were included by Bishop et al. [10] to the group of auxiliary tools used in the diagnosis of ASD are: *the Autism Diagnostic Interview – Revised* (ADI-R) [20] and *the Autism Observation Schedule – Second Edition* (ADOS-2) [21]. These are the tools used by professionals, mainly in the United States. The first tool in this group is a structured interview with a parent/caregiver of the child. ADOS-2 is a protocol to be completed while observing the diagnosed person. Both of the original tools are available on the WPS Publish websites: http://www.wpspublish.com/store/p/ 2648/autism-diagnostic-observation-schedule-second-edition-ados-2 and http://www.wpspublish.com/store/p/2645/ autism-diagnostic-interview-

revised-adi-r. The Polish versions of these tools developed by a team led by prof. E. Pisula and dr I. Chojnicka are expected to be published in the coming months by the Hogrefe Testcentrum publishing house. We also supplement the above group of tools with *the Autism Syndrome Severity Scale – Revitalization (Skala Nasilenia Syndromu Autyzmu – Rewitalizacja* – SNSA-R) [22], compliant with the diagnostic criteria for ASD according to DSM-5 [1]. The scale is used for determining the severity of individual symptoms of ASD. It is available from the authors.

Tools used for measuring behavioral indicators of the level of development of "theory of mind" and empathizing

The type of obtained data serves as the criterion that we have adopted for systematizing the tools currently used by Polish and foreign scholars to measure the level of development of "theory of mind" and empathizing skills.

The first group of tools encompasses questionnaires completed by a parent/caregiver of the examined child. This group includes: *the Theory of Mind Inventory* (TOMI) [23] designed for children aged 2 to 12 years, translated into Polish [24], available in its original version on the website of the Theory of Mind Inventory (http://www.theoryofmindinventory. com/about/test-description/) and a version of *the Empathy Quotient* (EQ) intended for children *(Empathy Quotient – Child,* EQ-C) (aged between 6 and 8 years) [25], also available in its original version on the website of *Autism Research Centre* (https://www.autism researchcentre.com/arc_tests).

Another group of tools used for measuring the level of development of "theory of mind" and empathizing skills are observation sheets filled out by a professional. This group includes the American *Theory of Mind Task Battery* [26] (available in the original version on the website of the Theory of Mind Inventory: http://www.theoryofmindinventory.com/task-battery), the British *Reading the Mind in the Eyes Test* (versions for adults [27] and children [28]), *the Cambridge Mindreading Face-Voice Battery* (CAM) (versions for adults [29] and children [30]) and *Faces Test* [31] (all available in the original, as well as in the Polish version, on the website of Autism Research Centre (https://www.autismresearchcentre. com/arc_tests), the American *Attention-Following and Initiating Joint Attention Protocol* [32], and *Early Social Communication Scales* (ESCS) [33], and also the Polish *Theory of Mind Mechanism Scale (Skala Mechanizmu Teorii Umysłu* –SToMM) [34] developed on the basis of a "theory of mind" educational program by J. Howlin, S. Baron-Cohen and J. Hadwin [35]. The last of these tools is available from the authors.

The tool which contains both questionnaires filled out by a parent/caregiver of the child and sheets to be filled out by a professional is *Theory of Mind Test by Steerneman* (TOM) [36]. It has been translated into Polish by prof. B. Winczura.

Another group of tools includes self-report questionnaires completed by the examined person: *the Empathy Quotient* (EQ) – versions for adults [37] and adolescents [38]. Polish version of the scale for adults, as well as the original language versions of

both of these versions of the EQ scale are available on the website of Autism Research Centre (https://www.autismresearchcentre.com/arc_tests).

Tools used to measure the behavioral indicators of the course of sensory integration processes

The tools currently used by Polish and foreign scholars to measure the behavioral indicators of sensory integration processes have been systematized according to the type of obtained data, similarly to the tools mentioned above.

The first group of tools includes questionnaires completed by a parent/caregiver of the child. Among them there are: the American *Sensory Experience Questionnaire* (SEQ) [39] for people with ASD of all ages, starting from small children (2-year-olds), and ending with the youth (under 16 years) (its version for children has been translated into Polish, in consultation with dr. M. Wiśniewska and is available, under the name *Kwestionariusz Doświadczeń Sensorycznych* [40], from the authors) and the Polish *Sensorimotor Development Questionnaire (Kwestionariusz Rozwoju Sensomotorycznego* – KRS) [41], designed for children with a variety of developmental difficulties, ranging in age from 2 to 12 (available from the EMPIS publishing house: https://empis.pl/is/431-kwestionariusz-sensomotoryczny-zbigniew-przyrowski.html).

The second group of tools consists of questionnaires used by therapists to diagnose the type of sensory integration disorders in people with a variety of developmental disorders. This group includes the American *Sensory Profile* (SP) [42], intended for children aged 3 years and more, as well as for adults. The original version of the tool is available from the Pearson publishing house (http://www.pearsonclinical.com/therapy/products/100000822 /sensory-profile-2.html). Another tool – the Polish *Child's Sensory Profile (Profil Sensoryczny Dziecka* – PSD) [43], is designed for children aged 3 to 10 years. It is available in the Psychological and Pedagogical Tests Laboratory (http://www.pracowniatestow.pl/pl/p/Profil-Sensoryczny-Dziecka-PSD/130).

Based on a self-report, *Sensory Perception Quotient* (SPQ) questionnaire [44] is rather an unusual instrument among the tools for measuring sensory integration processes in people with ASD. It is based on data obtained directly from the examined person. It measures the level of sensory reactivity in high-functioning individuals with ASD, both adults and adolescents. The tool has not been translated into Polish yet.

Tools used for measuring the neurophysiological indicators of autism severity

Tools measuring brain structures (such as computed tomography – CT, positron emission tomography – PET, magnetic resonance imaging – MRI) or brain function (such as functional magnetic resonance imaging – fMRI, electroencephalography – EEG, or eye tracking) do not allow for a direct diagnosis of autism severity in examined individuals. Instead, they provide information about specific ASD abnormalities in the brain structure and functioning, for example, significant enlargement of the brain

compared to typically developing peers [2], abnormalities in the construction of the cerebellum [3] or weaker blood flow in the temporal lobes compared to individuals in the control group [45].

Tools used for measuring the neurophysiological indicators of the development level of "theory of mind" and empathizing skills

Neurophysiological indicators of the development level of "theory of mind" and empathizing skills that have recently been measured in a variety of studies are eye movements and points of gaze fixation [6, 46], as well as the activity of particular brain areas [47].

The data obtained by taking measurements of eye movements with the use of an eye tracker in individuals with ASD while they were performing tasks in the field of "theory of mind" and empathizing skills, revealed the absence of development of the "implicit" phase of "theory of mind" in adults and adolescents with ASD, despite the fact that its "explicit" phase had been developed [6]. The data also indicated that adults and children with ASD have difficulties with eye fixation on socially important parts of the face (eyes and mouth), while having fixation of the eyes on the "peripheral" parts of the face (ears, cheeks, forehead) [46].

Studies using fMRI allowed for observing, in individuals with ASD, the functioning of these areas of the brain, which, in people with normal development, are active when performing tasks that require the "theory of mind" skills. It has been noted that their function in patients with ASD is not correct. These areas are: the amygdala, the cingulate sulcus, the occipital–parietal junction, and the secondary visual cortex [47].

Tools used for measuring the neurophysiological indicators of the course of sensory integration processes

Neurophysiological indicators of sensory integration processes in individuals with ASD are provided via the measurement of cortical auditory evoked potentials and the examination of optimum visual acuity. Using these methods, researchers were able to prove the existence, in people with ASD, of abnormalities in the areas of lateralization of preattentive processes responsible for the perception of auditory stimuli [48] and interhemispheric connections in the processing of the temporal and spatial aspects of visual stimuli [49].

Conclusions

When choosing the tool for measuring autism severity, sensory integration processes, or the level of development of "theory of mind" and empathizing skills, researchers and rehabilitation practitioners are often guided primarily by practical considerations (the availability of a given tool for the group of people at a particular

developmental age, the ways that these people communicate, and the level of development of their cognitive abilities) [23]. The systematization proposed in this article, while ordering the tools used for measuring the abovementioned variables according to the adopted criterion, reveals that while selecting measurement tools, researchers also need to consider the type of indicators they plan to analyze. Therefore, a researcher's or practitioner's choice of a particular tool requires him or her to decide within which of the following approaches to set the aims of the studies:

– studies measuring behavioral indicators; or
– studies measuring neurophysiological indicators of analyzed variables.

The current state of knowledge presented in references [23, 25–31] allows us to expect that the measurements of behavioral indicators of neurocognitive processes and severity of autism should point to the internal diversity of the group of people with ASD. Thus, researches conducted with the use of tools measuring these indicators enable us to make conclusions about the correlates of diversity in autism severity in individuals with ASD.

The measurement of neurophysiological indicators of these variables demonstrates that individuals with ASD have certain characteristic features: the lack of development of the implicit phase of neurocognitive processes, or different anatomy of some parts of the brain. Therefore, researches pertaining to the neurophysiological indicators of neurocognitive processes and autism severity provide data useful for verifying hypotheses regarding the pathomechanism of ASD.

References

1. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*, 5th ed. Washington, DC: APA; 2013.
2. Courchesne E, Karns CM, Davis HR, Ziccardi R, Carper R, Tigue Z et al. *Unusual brain growth patterns in early life in patients with autistic disorder: An MRI study*. Neurology. 2001; 57: 245–254.
3. Abell F, Krams M, Ashburner J, Passingham R, Friton K, Frackowiak R et al. *The neuroanatomy of autism: A voxwl based whole brain analysis of structural MRI scans in high functioning individuals*. Neuroreport. 1999; 10: 1647–1651.
4. Landi M, Merell I, Raggi ME, Galluccio N, Ciceri F, Bonfanti A. et al. *Association analysis of noncoding variants in Neuroligins 3 and 4X Genes with Autism Spectrum Disorder*. Int. J. Mol. Sci. 2016; 17, doi: 10.3390/ijms17101765.
5. Whiteley P, Shattock P, Knivsberg AM, Seim A, Reichelt KL,Todd L et al. *Gluten – and casein-free dietary intervention for autism spectrum conditions*. Front. Hum. Neurosci. 2013; 6, 10.3389/fnhum.2012.00344.
6. Senju A, Southgate V, White S, Frith U. *Mindblind eyes: An absence of spontaneous theory of mind in Asperger Syndrome*. Science. 2009; 325: 883–885.
7. Putko A. *Dziecięca „teoria umysłu" w fazie jawnej i utajonej a funkcje wykonawcze*. Poznan: Adam Mickiewicz University Press; 2008.

8. Baron-Cohen S. *The empathizing system. A revision of the 1994 model of the mindreading system*. In: Ellis B, Bjorklund D. ed. *Origins of the Social Mind*. New York: Guilford; 2005, p. 468–492.
9. Ayres J. *Sensory integration and the child*. Los Angeles: Western Psychological Services; 1991.
10. Bishop SL, Luyster R, Richler J, Lord C. *Diagnostic Assessment*. In: Chawarska K, Klin A, Volkmar FR. ed. *Autism Spectrum Disorders in Infants and Toddlers*. New York: Guilford; 2008, p. 23–49.
11. Reznick JS, Baranek GT, Reavis S, Watson LR, Crais ER. *A Parent-Report Instrument for identifying one-year-olds at risk for an eventual diagnosis of autism: The First Year Inventory*. J. Autism Dev. Disord. 2007; 37: 1691–1710.
12. Robins D, Fein D, Barton M, Green J. *The Modified-Checklist for Autism in Toddlers (MCHAT): An initial investigation in the early detection of autism and Pervasive Developmental Disorders*. J. Autism Dev. Disord. 2001; 31: 131–144.
13. Szczęsny E. *Diagnostyka autyzmu*. Medycyna Praktyczna – Pediatria. 2009; 3: 79–88.
14. Allison C, Baron-Cohen S, Wheelwright S, Charman T, Richler J, Brayne C. *The Quantitative Checklist for Autism in Toddlers (Q-CHAT): Psychometric properties*. J. Autism Dev. Disord. 2008; 38: 1414–1425.
15. Scott F, Baron-Cohen S, Bolton P, Brayne C. *The CAST (Childhood Asperger Syndrome Test): Preliminary development of UK screen for mainstream primary-school children*. Autism. 2002; 6: 9–31.
16. Auyeung B, Baron-Cohen S, Wheelwright S, Allison C. *The Autism-Spectrum Quotient: Children's Version (AQ-Child)*. J. Autism Dev. Disord. 2008; 38: 1230–1240.
17. Baron-Cohen S, Hoekstra RA, Knickmeyer R, Wheelwright S. *The Autism-Spectrum Quotient (AQ) – adolescent version*. J. Autism Dev. Disord. 2006; 36: 343–350.
18. Baron-Cohen S, Wheelwright S, Skinner R, Martin J, Clubley E. *The Autism-Spectrum Quotient (AQ)*. J. Autism Dev. Disord. 2001; 31: 5–17.
19. Schopler E, Reichler R, DeVellis R. *Toward objective classification of childhood autism: Childhood autism rating scale (CARS)*. J. Autism Dev. Disord. 1980; 10: 91–103.
20. Lord C, Rutter M, Le Couteur A. *The Autism Diagnostic Interview – Revised: A revised version of diagnostic interview for caregivers of indyviduals with possible pervasive developmental disorders*. J. Autism Dev. Disord. 1994; 24: 659–685.
21. Luyster R, Gotham K, Guthree W, Coffing M, Petrok R, Pierce K. et al. *The Autism Diagnostic Observation Schedule – Toddler Module: A new module of a Standardized Diagnostic Measure for Autsim Spectrum Disorders*. J. Autism Dev. Disord. 2009; 39: 1305–1320.
22. Krzysztofik K, Otrębski W. *Skala Nasilenia Syndromu Autyzmu – Rewitalizacja*. Lublin: KPReh KUL; 2016.
23. Hutchins TL, Prelock PA, Bonazinga L. *Psychometric evaluation of The Theory of Mind Inventory (TOMI): A study of typically developing children and children with Autism Spectrum Disorder*. J. Autism Dev. Disord. 2012; 42: 327–341.
24. Kossewska J. *Parents' subjective perception of the development of Deaf children's theory of mind*. In: Baran J, Cierpiałowska T, Plutecka K. ed. *Chosen topics of supporting persons with a disability*. Krakow: Impuls Publishing House; 2013, p. 143–166.
25. Chapman E, Baron-Cohen S, Auyeung B, Knickmeyer R, Taylor K, Hackett G. *Fetal testosterone and empathy: Evidence form the Empathy Quotient (EQ) and tne "Reading the Mind in the eyes" Test*. Soc. Neurosci.-UK. 2006; 2: 135–148.

26. Hutchins TL, Prelock PA, Chace W. *Test-Retest Reliability of Theory of a Mind Task Battery for Children with Autism Spectrum Disorders*. Focus Autism Dev. Dis. 2008; 23: 195–206.
27. Baron-Cohen S, Jolliffe T, Mortimore C, Robertson M. *Another advanced test of theory of mind: evidence from very high functioning adults with autism or Asperger Syndrome*. J. Child Psychol. Psyc. 1997; 38: 813–822.
28. Baron-Cohen S, Wheelwright S, Scahill V, Lawson L, Spong A. *Are intuitive physics and intuitive psychology independent? A test with children with Asperger Syndrome*. Journal of Developmental and Learning Disorders. 2001; 5: 47–78.
29. Golan O, Baron-Cohen S, Hill J. *The Cambridge Mindreading (CAM) Face-Voice Battery: Testing complex emotion recognition in adults with and without Asperger Syndrome*. J. Autism Dev. Disord. 2006; 2: 169–183.
30. Golan O, Sinai-Gavrilov Y, Baron-Cohen S. *The Cambridge Mindreading Face-Voice Battery for Children (CAM-C): complex emotion recognition in children with and without autism spectrum condition*. Mol. Autism. 2015; 6, doi: 10.1186/s13229-015-0018-z.
31. Baron-Cohen S, Wheelwright S, Jolliffe T. *Is there a "language of the eyes"? Evidence from normal adults and adults with autism or Asperger Syndrome*. Vis. Cogn. 1997; 4: 311–331.
32. Watson LR, Baranek GT, Poston V. *Attention-Following and Initiating Joint Attention Protocol*. Chapel Hill: University of North Carolina at Chapel Hill; 2003.
33. Mundy P, Delgado Ch, Block J, Venezia M, Hogan A, Seibert J. *Early Social Communication Scales (ESCS)*. Coral Gables: University of Miami; 2003.
34. Krzysztofik K. *Skala Mechanizmu Teorii Umysłu (SToMM)*. Lublin: KPReh KUL; 2016.
35. Hadwin J, Baron-Cohen S, Howlin P, Hill K. *Can we teach children with autism to understand emotions, belief and pretence?* Dev. Psychopathol. 1996; 8: 345–365.
36. Winczura B. *Dziecko z autyzmem. Terapia deficytów poznawczych a teoria umysłu*. Krakow: Impuls; 2008.
37. Baron-Cohen S, Wheelwright S. *The Empathy Quotient (EQ): An investigation of adults with Asperger Syndrome or high-functioning autism, and normal sex differences*. J. Autism Dev. Disord. 2004; 34: 163–175.
38. Auyeung B, Allison C, Wheelwright S, Baron-Cohen S. *Brief Report: Development of the Adolescent Empathy and Systemizing Quotients*. J. Autism Dev. Disord. 2012; 42: 2225–2235.
39. Baranek GT. *Sensory Experience Questionnaire (SEQ) version 2.1. Division of Occupational Science and Occupational Therapy*. Chapel Hill: University of North Carolina at Chapel Hill; 1999.
40. Krzysztofik K, Otrębski W. *Kwestionariusz Doświadczeń Sensorycznych (KDS)*. Lublin: KPReh KUL; 2016.
41. Przyrowski Z. *Kwestionariusz Rozwoju Sensomotorycznego*. Warsaw: Empis; 2010.
42. Dunn W. *Sensory Profile*. San Antonio: TX The Psychological Corporation; 1999.
43. Wiśniewska M. *Profil Sensoryczny Dziecka*. Gdansk: Psychological and Pedagogical Test Laoratory; 2015.
44. Tavassoli T, Hoekstra RA, Baron-Cohen S. *The Sensory Perception Quotient (SPQ): development and validation of a new sensory questionnaire for adults with and without autism*. Mol. Autism. 2014; 5, doi: 10.1186/2040-2392-5-29.
45. Onishi T, Matsuda H, Hashimoto T, Kunihiro T, Nisihikawa M, Uema T et al. *Abnormal regional cerebrall blood flow in childhood autism*. Brain. 2000; 123: 1838–1844.
46. Irwin JR, Brancanzio L. *Seeing to hear? Patterns of gaze to speaking faces in children with autism spectrum disorders*. Front. Psychol. 2014; 5, doi: 10.3389/fpsyg.2014.00397.

47. Castelli F, Frith CD, Happe F, Frith U. *Autism, Aspereger Syndrome and brain mechanisms for the attribution of mental states to animated shapes*. Brain. 2002; 125: 1–11.
48. Stroganova TA, Kozunov VV, Posikera NI, Galuta IA, Gratchev VV, Orekhova EV. *Abnormal Pre-Attentive Arousal in young children with Autism Spectrum Disorder contributes to their atypical auditory behavior: An ERP Study*. Plos One. 2013; 8, doi: 10.1371/journal.pone.0069100.
49. Latham K, Chung STL, Allen PM, Tavassoli T, Baron-Cohen S. *Spatial localisation in autism: evidence for differences in early cortical visual processing*. Mol. Autism. 2013; 4, doi: 10.1186/2040-2392-4-4.

Address: Karolina Krzysztofik
Chair of Rehabilitation Psychology
John Paul II Catholic University of Lublin
20-950 Lublin, Al. Racławickie Street 14